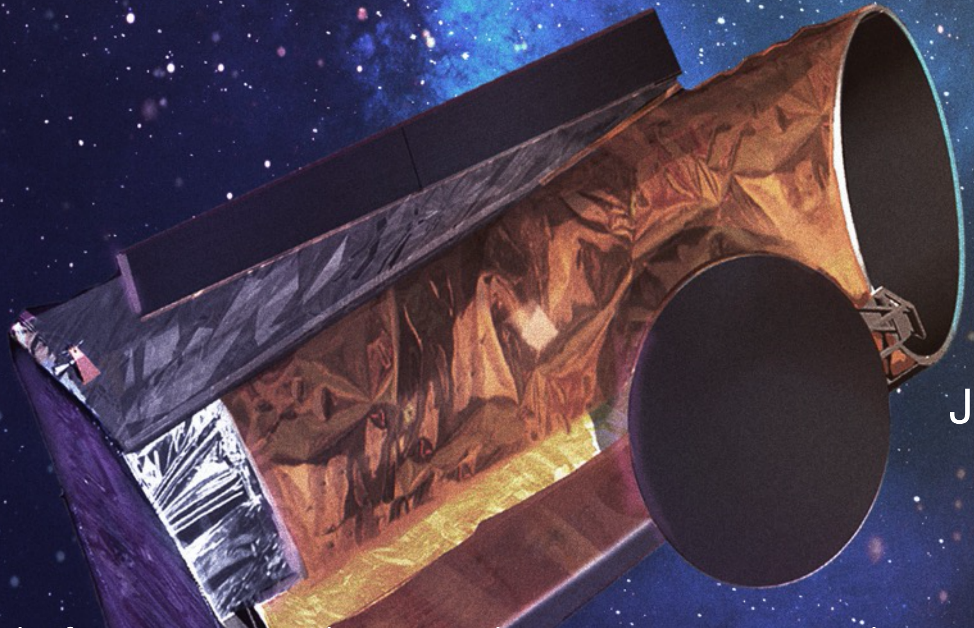
The Habitable Exoplanet Observatory Concept

Exploring planetary systems around our neighboring sunlike stars and enabling a broad range of observatory science in the UV through the near-IR



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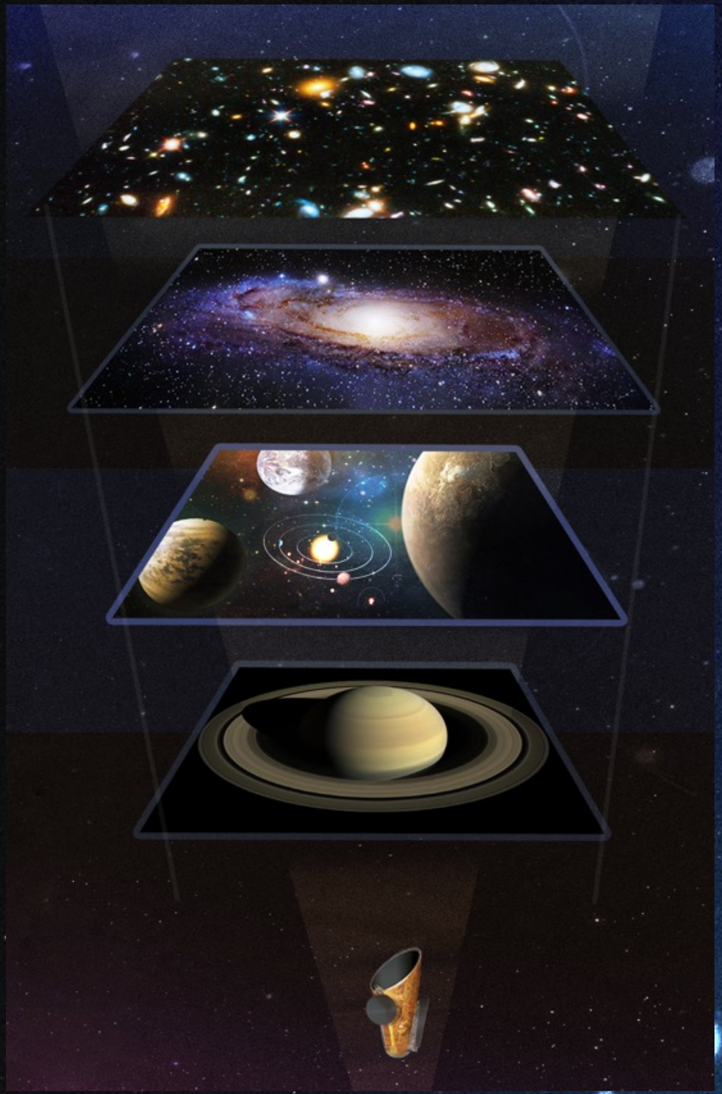
The Next-Generation Great Observatory

- Through a community-driven competed and funded Guest Observer program, HabEx will enable extensive physics of the cosmos, cosmic origins, exoplanet exploration, and solar system science.

- To be sensitive to an uncertain future landscape, a matrix of 9 architectures of varying scope have been investigated.

- The HabEx concept is an exciting design that is budget conscious, low risk, and technologically implementable in the 2020s.

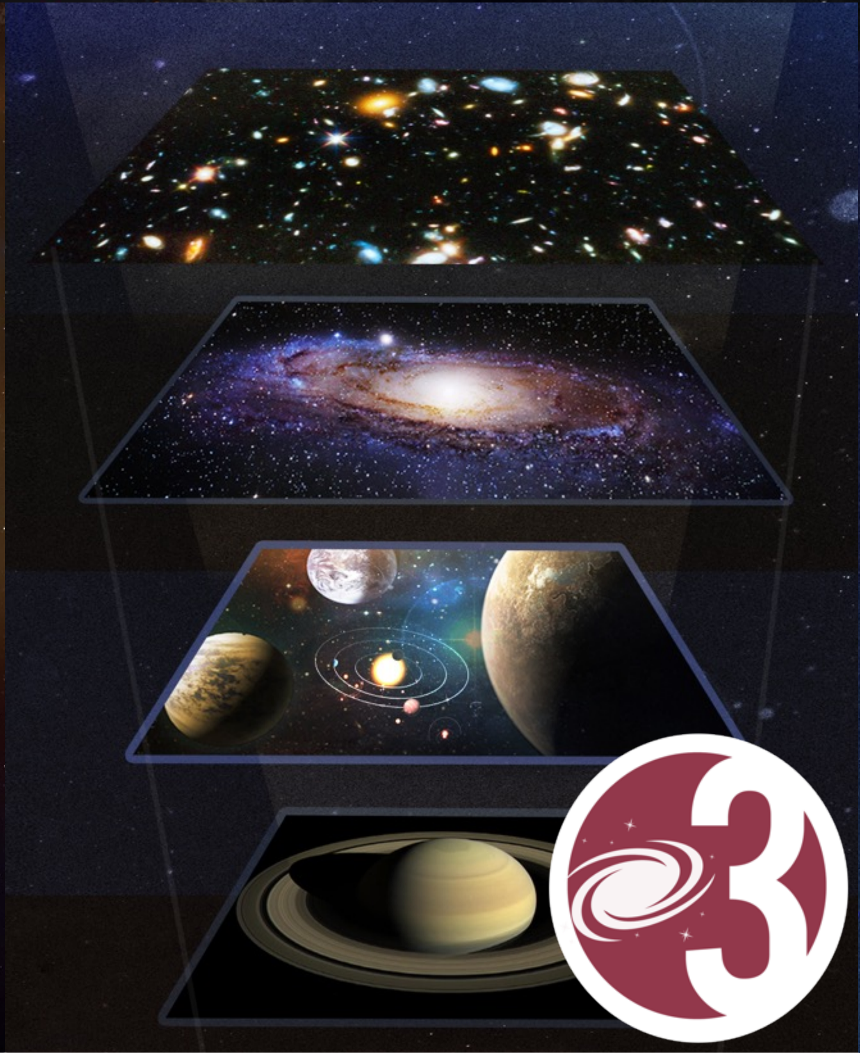


HabEx

Science Goals

Seek out nearby worlds and explore their habitability

Map out nearby planetary systems and understand their diversity.



Enable new explorations of systems in the UV to near-IR

HabEx

Observing Time Allocations

Broad Survey: non-exo-Earths
Starshade
0.5 y (~35 visits)

Broad Survey: exo-Earths
Starshade
0.65 y (~25 visits)

Broad Survey
Coronagraph
1.1 y (~280 visits)

Deep Survey
Starshade
0.25 y (~25 visits)

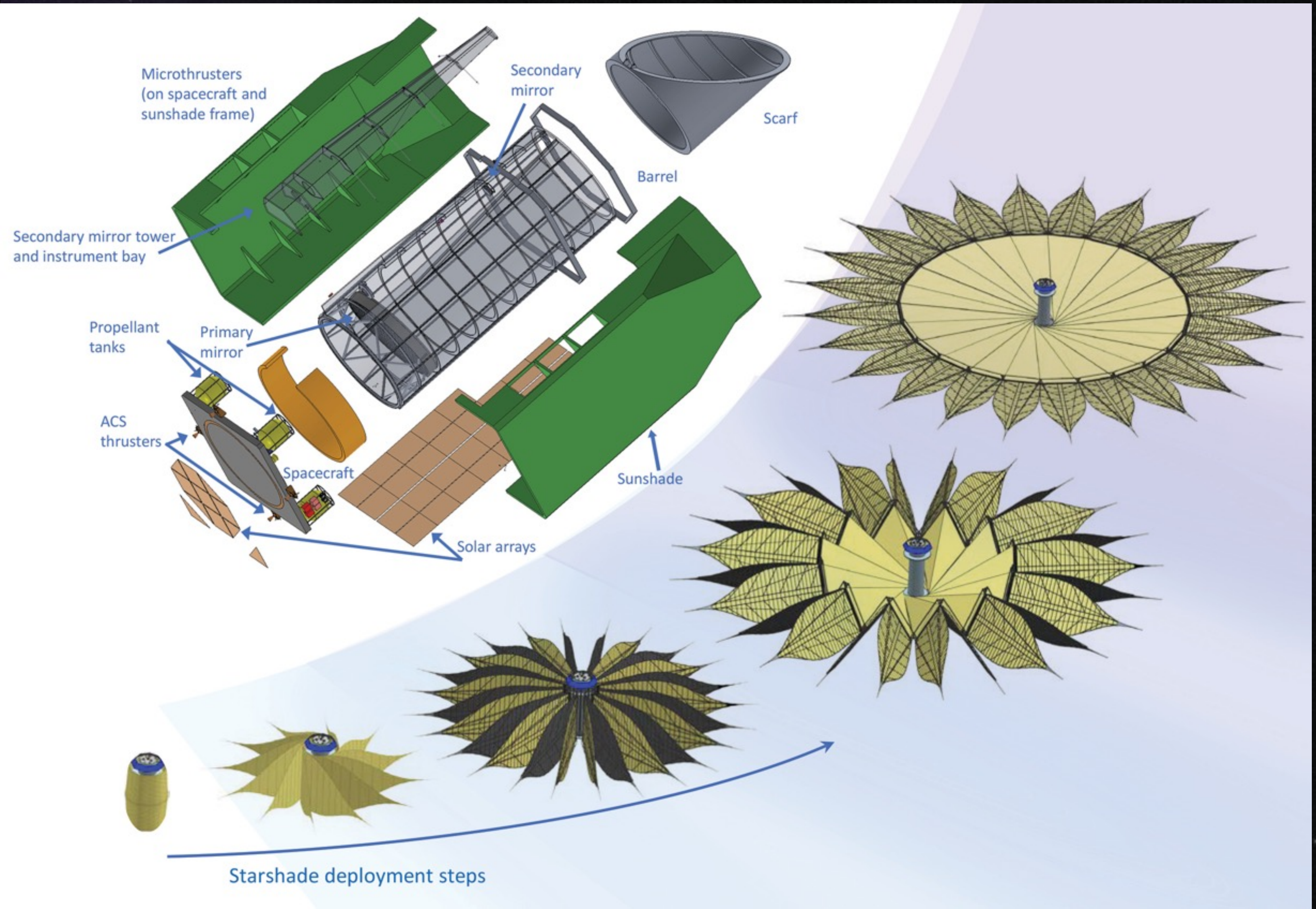
Parallel Observation Program
UVS & HWC
2.5 y

Guest Observer Program
All Instruments
2.5 y

- 50% GO Time
- 50% Parallel Obs Time
- 50% Exoplanet Survey Time

Baseline Architecture

Baseline Architecture

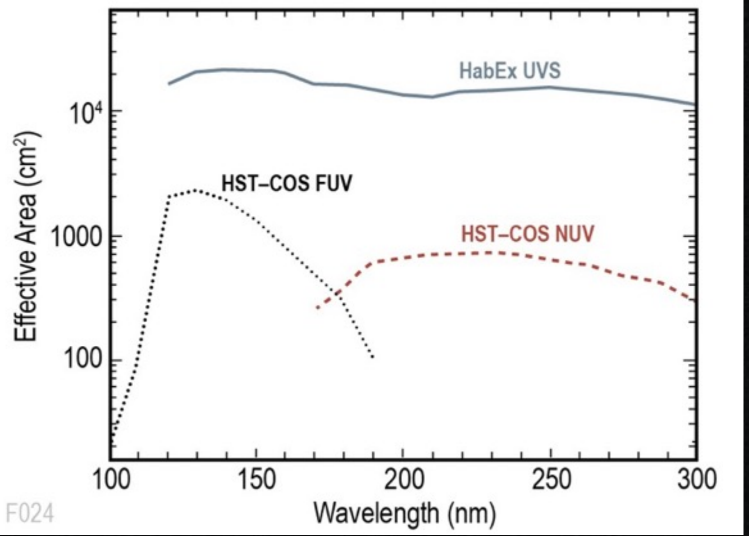


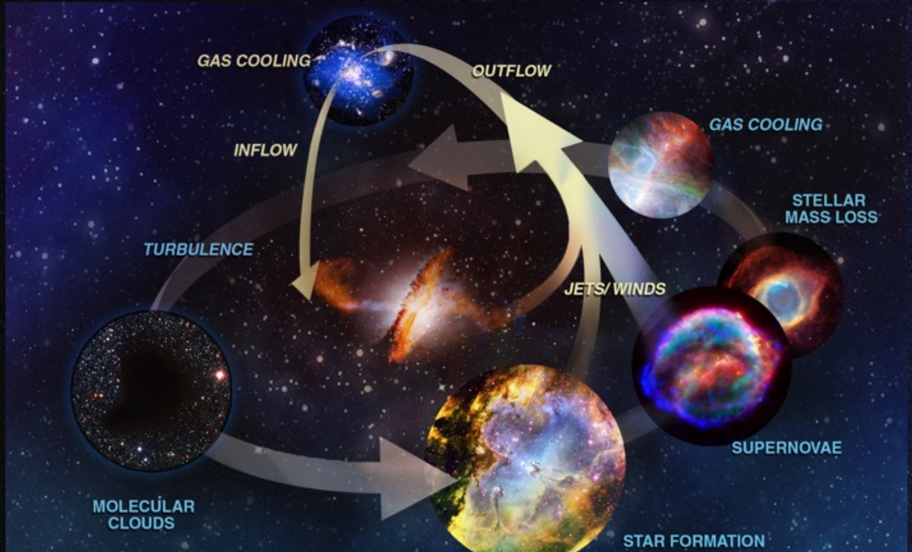
	Habitable Exoplanet Observatory (HabEx)
Mission Duration	5 years (10 years consumables)
Orbit	Earth-Sun L2 Halo
Telescope Aperture	4-meter unobscured
Telescope Type	Off-axis three-mirror anastigmat
Primary Mirror	4-meter monolith; glass-ceramic substrate; Al+MgF2 coating
Instruments (4)	Exoplanet science: Coronagraph, Starshade Observatory science: UV Spectrograph, Workhorse Camera
Attitude Control	Slewing: hydrazine thrusters; Pointing: microthrusters

Ultraviolet Spectrograph (UVS)

HabEx

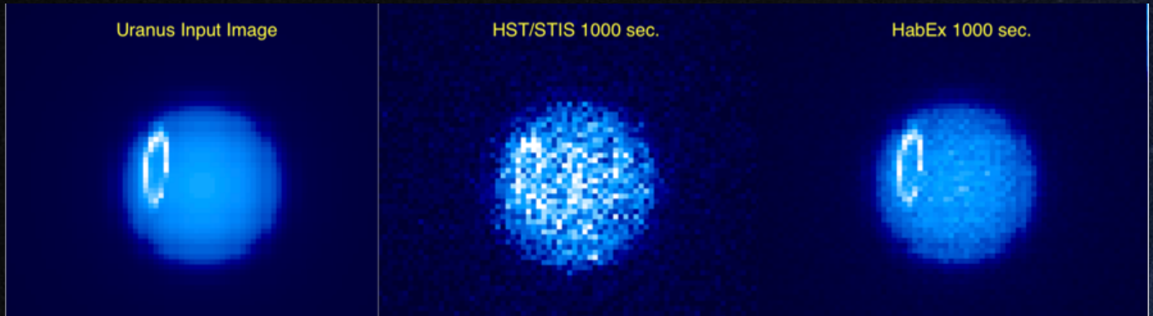
High-resolution UV imaging and spectroscopy





The lifecycle of baryons

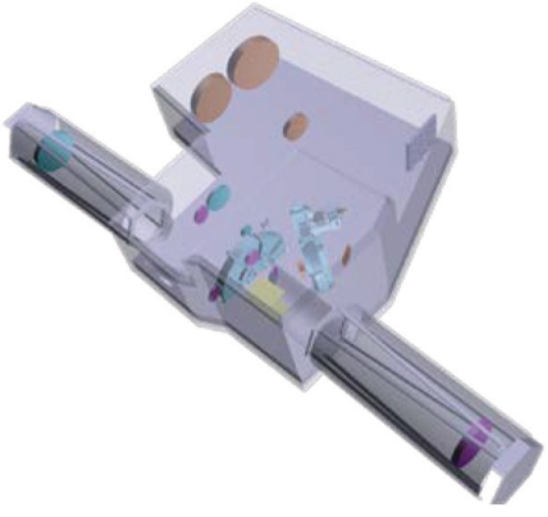
Field-of-view	3 x 3 arcmin^2
Wavelength bands	20 bands covering 0.115 to 0.32 μm
Spectral resolutions	60,000; 25,000; 12,000; 6,000; 3,000;1,000; 500
Telescope resolution	Diffraction limited at 0.4 μm
Detector	3x5 MCP array, 100mm sq each

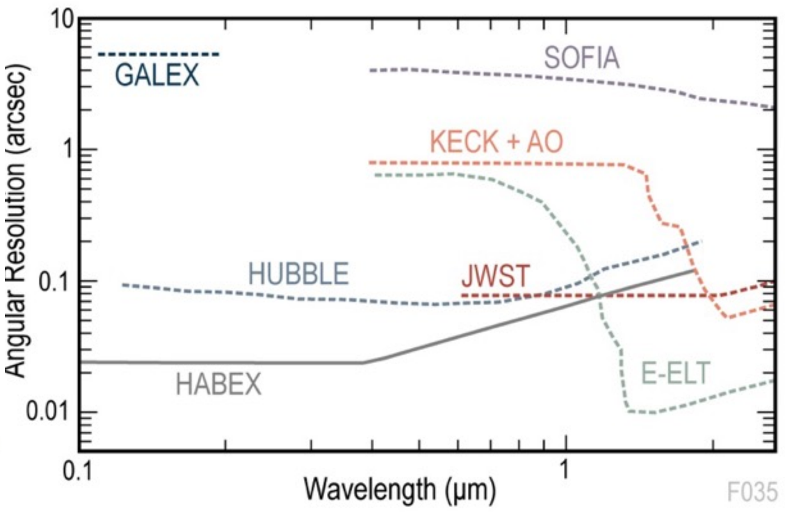


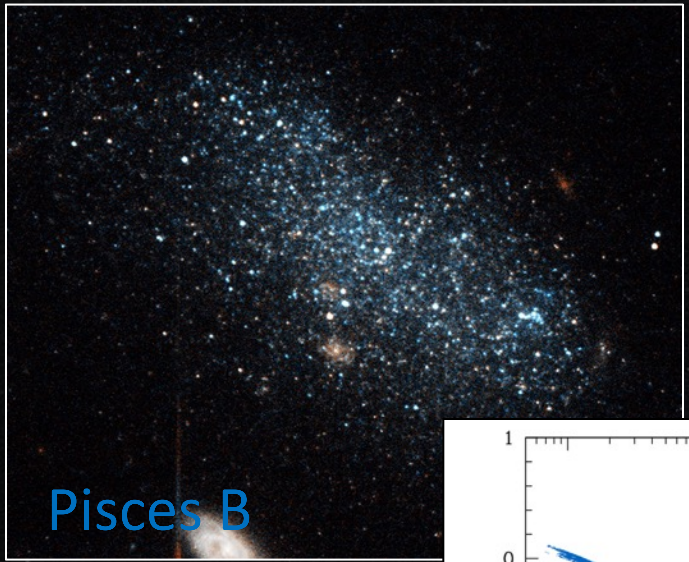
Solar System Aurorae

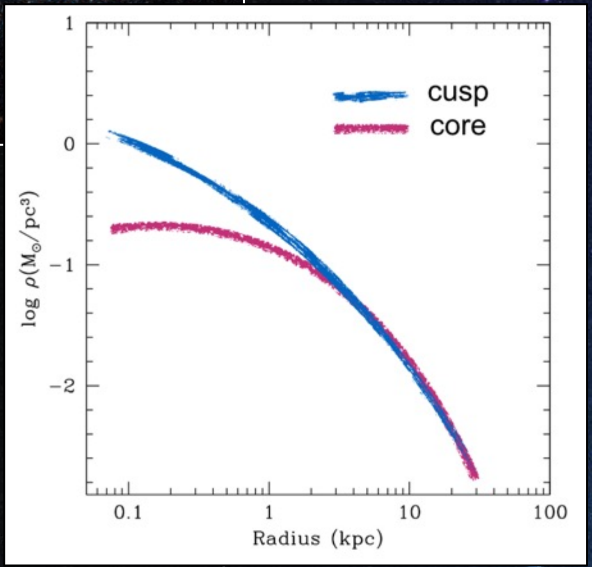
HabEx Workhorse Camera (HWC)

Multi-purpose optical to near-IR wide-field imaging and spectroscopy









Dark matter in dwarf galaxies

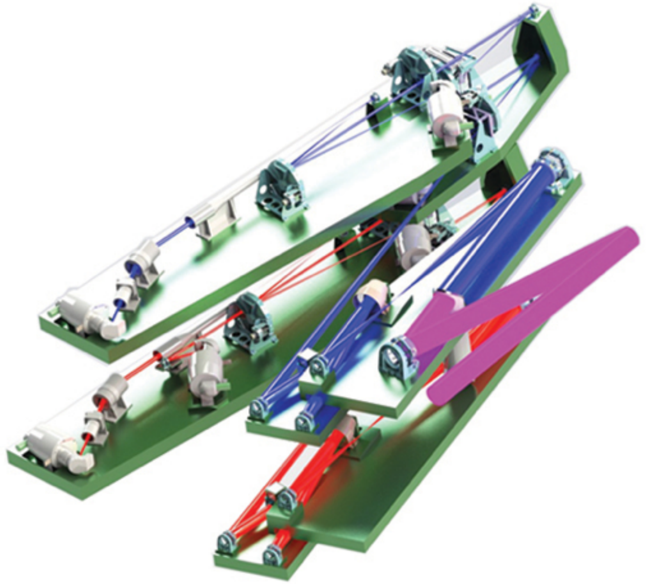
	Vis Channel	near-IR Channel
Field-of-view	3 x 3 arcmin^2	3 x 3 arcmin^2
Wavelength bands	0.37 – 0.975 µm	0.975 – 1.8 µm
Spectral resolution	1000	1000
Telescope resolution	30.9 mas	49 mas
Detectors	3x3 CCD203	2x2 H4RG10

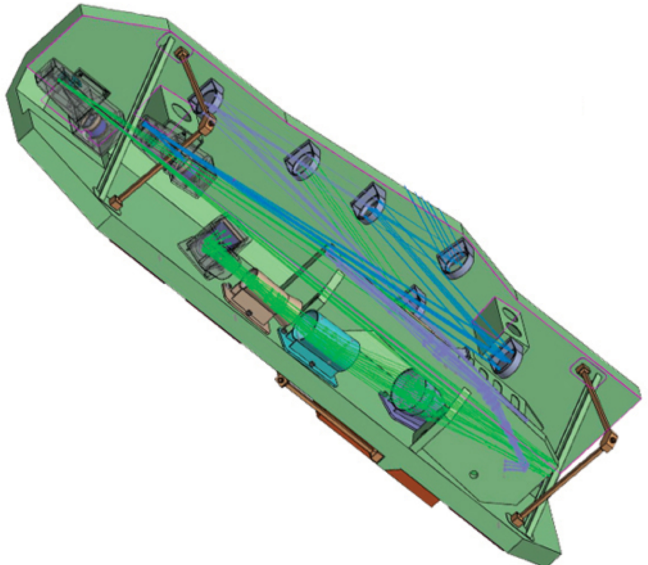
Coronagraph and Starshade Instruments

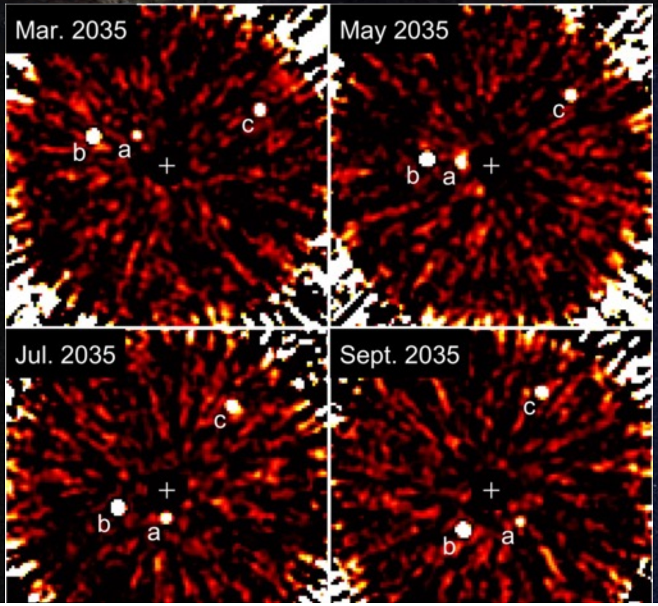
HabEx

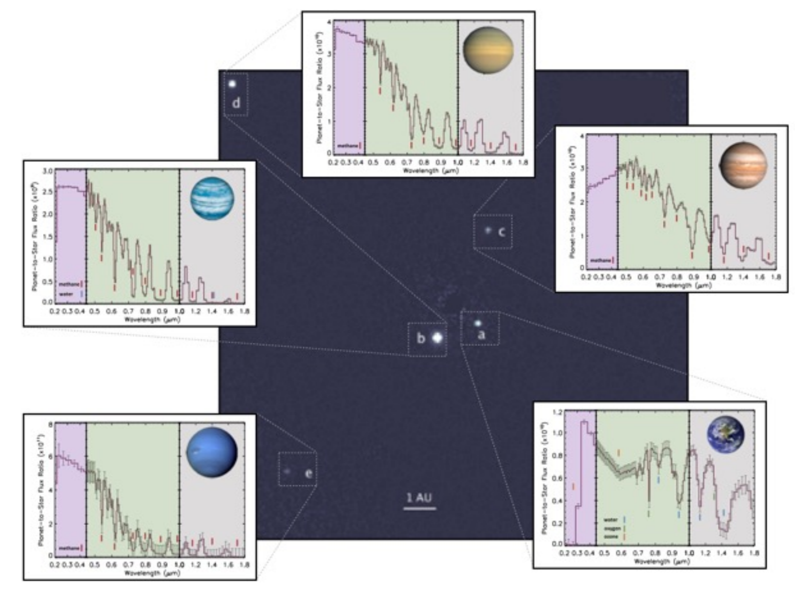
HabEx Coronagraph	Blue Channel	Red Channel	Near-IR Channel
Field-of-view	1.5x1.5 arcsec^2	2.2x2.2 arcsec^2	3.1x3.1 arcsec^2
Wavelength bands	0.45 – 0.55 μm 0.55 – 0.67 μm	0.67 – 0.82 μm 0.82 – 1.0 μm	0.975 – 1.8 μm (in 3 20% bands)
Telescope resolution	23 mas @ 0.45 μm	42 mas @ 0.82 μm	49 mas @ 0.95 μm
IWA	56 mas	102 mas	118 mas
OWA	0.74 arcsec	1.11 arcsec	1.57 arcsec
Spectral resolution	140	140	40

HabEx Starshade	UV Channel	Visible Channel	Near-IR Channel
Imaging field-of-view	10 x 10 arcsec^2	12 x 12 arcsec^2	Pupil imager
Wavelength bands	0.2 – 0.45 μm	0.45 – 0.975 μm	0.975 – 1.8 μm
Telescope resolution	21 mas	21 mas	-
$IWA_{0.5}$	39 mas	58 mas	104 mas
Spectral resolution	7	140	40





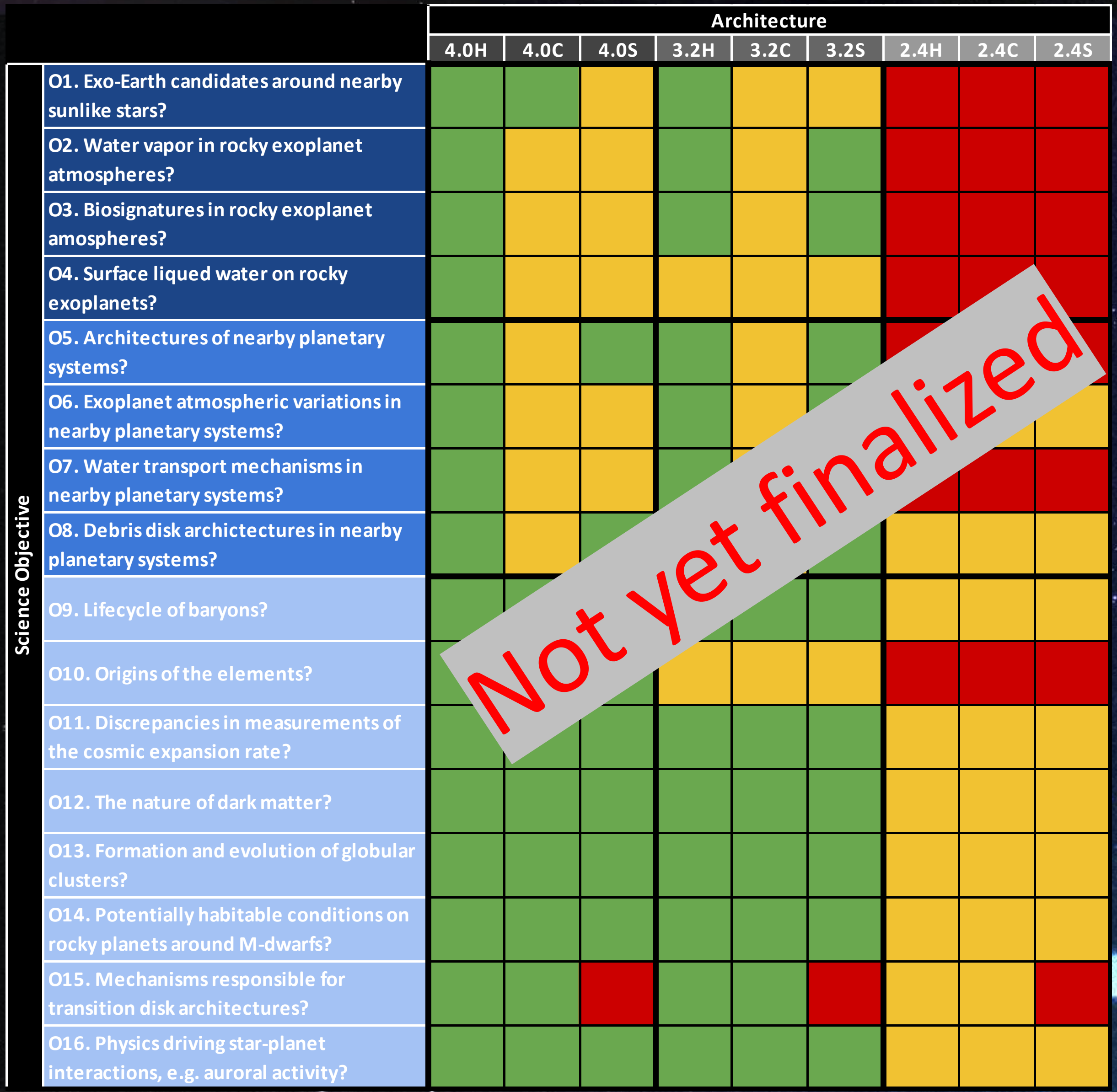




Architecture Options

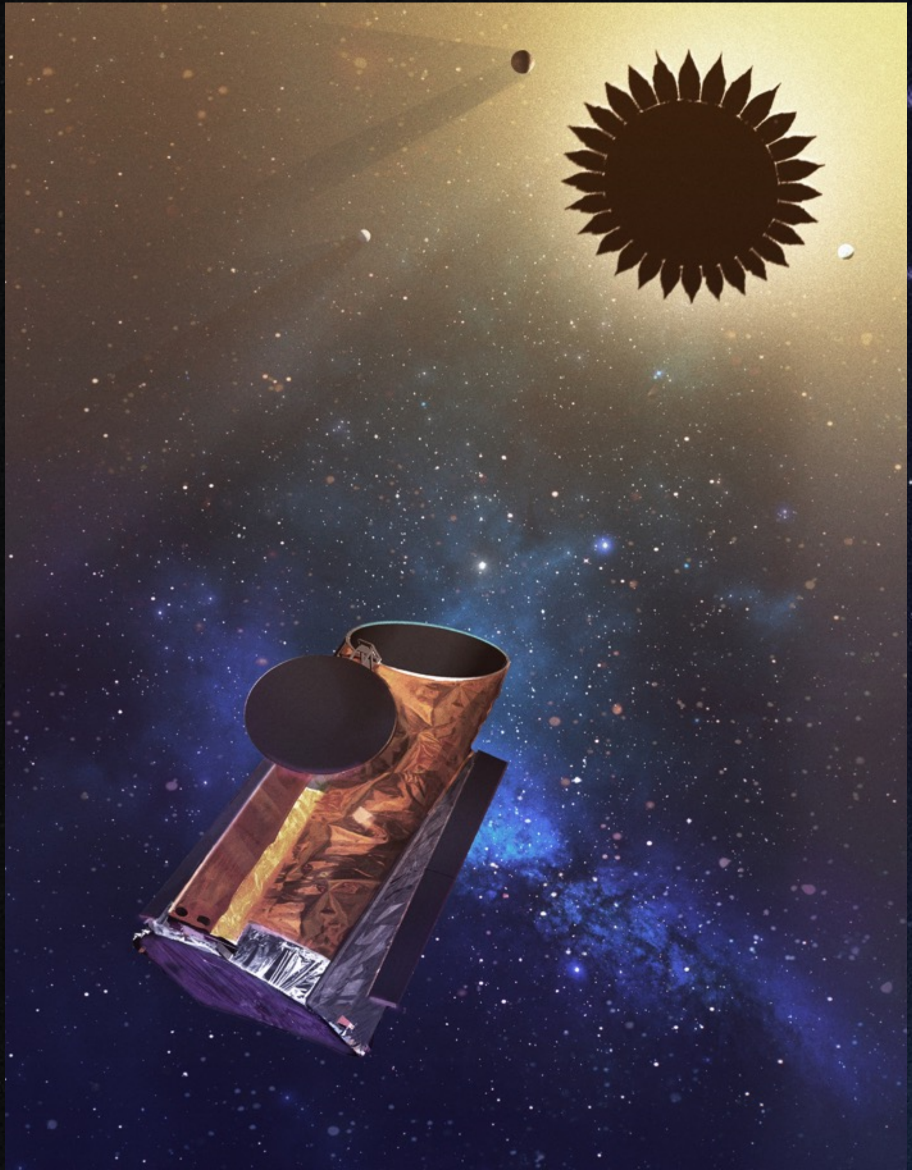
9 architectures investigated

- Three aperture options: 4m; 3.2m; 2.4m.
- All apertures and options include the UVS and HWC instruments.
- Three options for exoplanet instruments per aperture:
  - Hybrid **(H)** with both coronagraph and starshade instruments using an off-axis monolithic primary mirror.
  - Coronagraph instrument only **(C)** using an off-axis monolithic telescope primary mirror.
  - Starshade instrument only **(S)** using an on-axis segmented primary mirror.

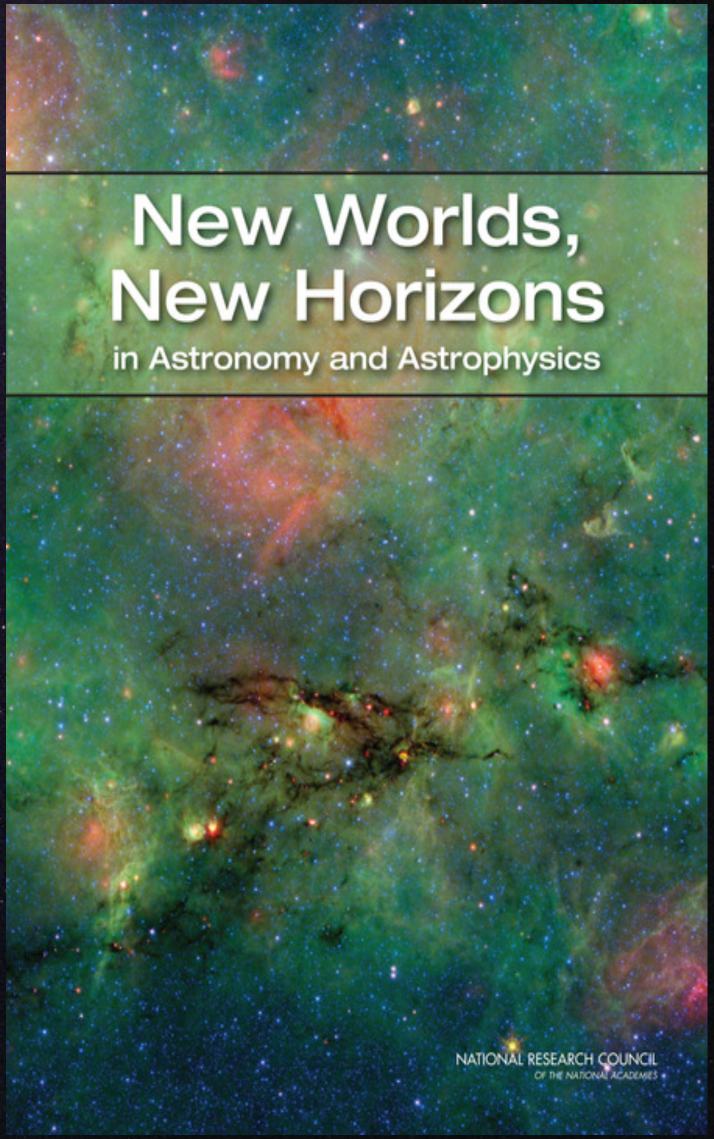


Community White Papers

- What would YOU do with HabEx?!
- The HabEx Team is soliciting 2-page community white papers to include in the HabEx Final Report.
- Email Rashied Amini for a template: Rashied.Amini@jpl.nasa.gov



The Astrophysics Decadal Survey



- The National Research Council convenes experts to define the ground- and space-based Astrophysics priorities for the next 10 years.
- For large space-based telescopes –
  - The 2000 Decadal Survey prioritized the James Webb Space Telescope (JWST), which will launch in ~2021.
  - The 2010 Decadal Survey prioritized the Wide Field Infrared Survey Telescope (WFIRST), which will launch in ~2025.
  - The Habitable Exoplanet Observatory **(HabEx)** is one of four “flagship” mission studies currently being undertaken by NASA for consideration in the **2020 Decadal Survey**. If prioritized, HabEx would launch in the mid-to-late 2030’s.
  - The other studies are:
    - The Origins Space Telescope (OST)
    - The Large UV, Optical, IR Telescope (LUVOIR)
    - Lynx

Study Goals

"Develop an optimal* mission concept for characterizing our nearest planetary systems, and detecting and characterizing a handful of ExoEarths."

"Given this optimal* concept, maximize the astrophysics science potential without sacrificing the primary exoplanet science goals."

What does optimal mean?

- Maximizing the science yield while maintaining feasibility, i.e., adhering to expected constraints.
- Constraints include: Cost, technology (risk), time to develop mission.